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# Perceived Impact of Spatial Connectivity in Learning Environments on Social Engagement: Collaboration Between Teachers, Students, and Architects

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ABSTRACT

*This study investigates the role of spatial connectivity in learning environments and its impact on social engagement, focusing on perceptions from teachers, students, and architects regarding a collaborative design model. Employing a multi-method approach that combines case study analysis and Space Syntax methodology, the research explores how spatial layouts influence social interactions and engagement. Ten focus groups of teachers, students, and architects identified key spaces fostering social connections and collaboration. The proposed redesign shifts from a traditional hierarchical structure to a more flexible layout, with classrooms arranged around a central common space to encourage social interaction. Data analysis, conducted using structured coding by Atlas-ti and Space Syntax tools like Convex Map and Axial Line Analysis, identified themes related to spatial diversity, adaptability, transparency, and the balance between open and focused spaces. The findings highlight the importance of adaptable, multifunctional spaces, and the need for spaces that promote social interaction and privacy. The study contributes valuable insights into how spatial configurations can foster collaboration and engagement in educational settings.*

**KEY WORDS:** Social Engagement, Spatial Connectivity, Space Syntax, Learning Environment



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## Introduction

The concept of space has become increasingly significant in the social sciences, especially in understanding phenomena within the humanities and social sciences. Scholars are recognizing the importance of spatial relationships in shaping research and addressing various topics (Zhang et al., 2024). This shift has led to a broader exploration of how spatial dimensions influence different areas of study. Rapid changes in the physical learning environment are impacting the educational process. These shifts call for an in-depth examination of how educational spaces can adapt to these changes and their capacity to support future developments (Dovey & Fisher, 2014; Sweilam, 2021).

Space Syntax is a key tool used to evaluate spatial configurations and their impact on social engagement. By analyzing how space influences interactions, Space Syntax offers insights into the relationship between school architecture and the learning experience. This approach highlights how space can shape social dynamics and organizational structures, including the formation of clusters within environments (Saghafi & Mirzaei, 2021).

This paper examines Space Syntax's socio-spatial metrics such as depth, choice, connectivity, integration, and control to understand how spatial layout influences social engagement in school settings. Through a literature review, empirical case study, and spatial analysis, the paper explores how spatial configurations in schools impact social interaction. The goal is to determine how the design of educational spaces can enhance social engagement and inform better school design practices.

## Literature Review

This section explains the connection between physical space, social engagement, and Space Syntax methodology as a tool for understanding spatial configurations in learning environments.

***The connection between physical space and social engagement***

The design of physical space plays a significant role in shaping social engagement, affecting student interactions and the learning experience. Studies highlight that spatial qualities like layout, acoustics, privacy, movement, and flexibility directly impact student behavior, collaboration, and learning outcomes (Gislason, 2010). While space design is essential for fostering individual concentration and group collaboration, it presents challenges in balancing these needs. Educators and designers must carefully consider how different aspects of space contribute to social interactions and how best to design environments that promote focused work and social connection, enhancing the overall educational experience.

Open-plan classrooms are frequently praised for their potential to support student interaction and flexible learning. Such spaces offer adaptability for diverse teaching methods and student needs, fostering dynamic and collaborative learning experiences (Carvalho & Yeoman, 2018; Gislason, 2009). However, open spaces often lead to challenges like noise, lack of privacy, and decision fatigue, with students overwhelmed by too many choices. Finding the right balance between flexibility, privacy, and acoustics is essential for creating a conducive learning environment. Researchers suggest zoning, soundproofing, and modular designs as potential solutions, though further empirical studies are needed to evaluate their effectiveness (Yeoman, 2018; Gislason, 2009).

Traditional enclosed classrooms are known for providing a stable, focused environment conducive to teacher-led instruction (Cardellino & Woolner, 2020). However, they typically restrict opportunities for student collaboration and social interaction, which are vital components of modern education (Woodman, 2016). The challenge lies in redesigning these classrooms to support individual concentration and group work. There is a need for more research on integrating movement and flexible design within traditional classrooms, enabling students to collaborate and engage while maintaining focus. Understanding how movement and space configuration can enhance learning in traditional settings is an area that requires further exploration.

Movement within educational spaces is essential for promoting student engagement and fostering interaction. Studies suggest that how students move within a space influences their social engagement (Woodman, 2016; Dewey, 1985). Spatial configuration, including informal and structured activity zones, plays a key role in how movement occurs. Research by Bradbeer et al. (2019) and Saghafi and Mirzaei (2021) emphasizes how these configurations impact student interaction and engagement. However, further studies are needed to understand how specific types of movement, such as informal or group-based movement, support particular learning activities like problem-solving or critical thinking, which can lead to more effective space designs.

This research aims to address gaps in the literature by combining Space Syntax methodology with collaborative design to explore how spatial connectivity influences social engagement in educational environments. Involving teachers, students, and architects in assessing proposed school layouts offers insights into how different spatial configurations impact social interaction and learning outcomes. By integrating user feedback with real-time analysis, this study provides a comprehensive understanding of how spatial qualities can be optimized to foster social interaction. The research extends Space Syntax’s application to educational settings, contributing to a better understanding of how space design influences engagement in schools. This methodology not only provides a detailed framework for analyzing the impact of spatial design on social interactions but also sets the stage for future research, offering practical applications for enhancing school design and fostering better social engagement among students.

## Research Methodology

This study examines how spatial connectivity in learning environments affects social engagement, focusing on teacher and student perceptions of a proposed model developed through a collaborative process. Using a multi-method approach with case study and content analysis, grounded in Space Syntax, the study applies an interpretive philosophy and inductive reasoning. 10 focus groups discussed how specific areas and spatial layouts can promote social engagement. The proposed model for Razi High School, was shaped by participant contributions, transforming the school's traditional hierarchical structure into a flexible layout with clusters of classrooms around a central common space to enhance social interaction and engagement.


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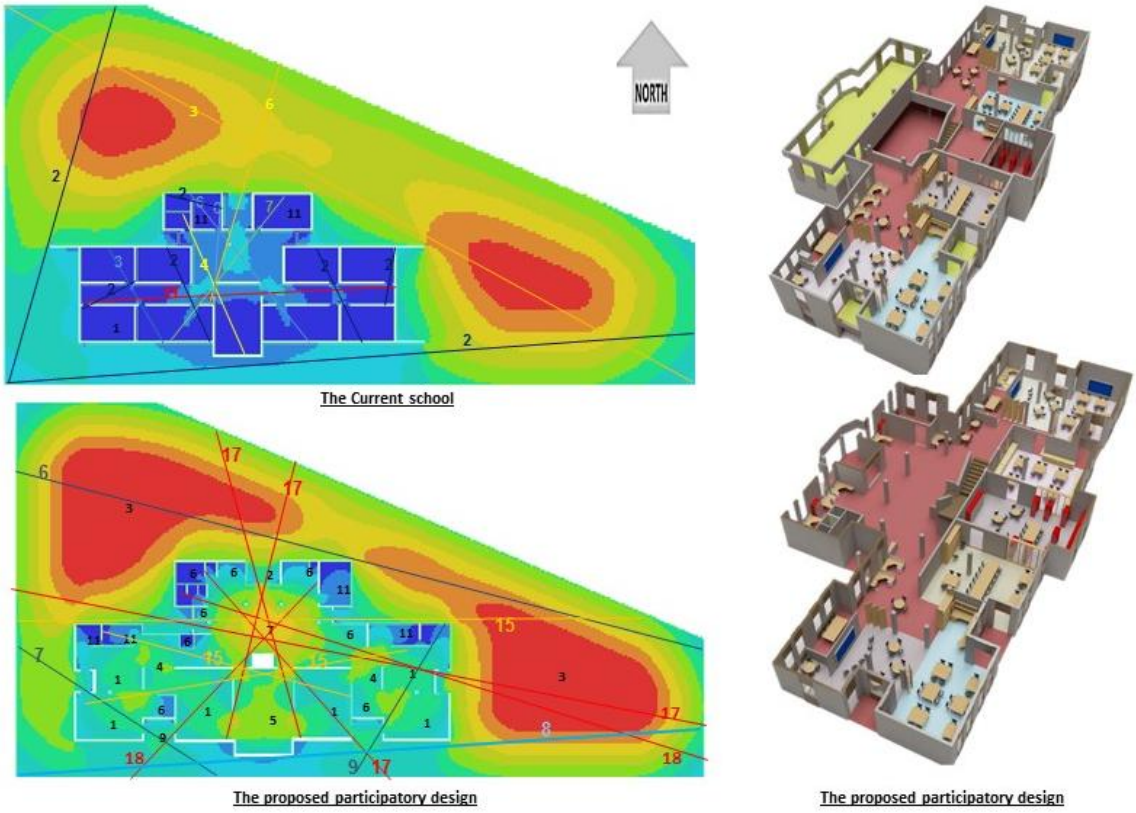


Figure 1 Case study and Space Syntax analysis

***Data Collection and Focus Groups***

Focus groups used diagrams, bubble sketches, and textual descriptions to identify key spaces that foster social engagement and their connections to neighboring areas. Discussions focused on the importance of specific spaces and how different modes of interaction, such as communication and collaboration, can either facilitate or hinder social connections. Research questions included: How do spatial relationships, such as proximity and visibility, influence social engagement? Which spaces are most conducive to fostering social interactions? Participants emphasized the role of spatial relationships in shaping dynamics. The iterative process included feedback loops, where Space Syntax outputs were shared for further refinement and validation (Table 1).

Table 1 Demography of participants

| | Architects | Students | Teachers |
|---|---|---|---|
| Age | 30-50 | 16-18 | 30-50 |
| Gender | Female and male | Female | Female |
| Education Level | At least a master's degree or above | Senior at high school | At least bachelor's degree or above |
| Expertise and Experience | Designing learning environments, Experience in using Space Syntax | Prior experience in designing their school through their participation | Prior experience in designing their school through their participation |
| Work situation | Self-employed architect | Student | Full-time teacher |

***Research Questions***

- How do students and teachers perceive the connectivity of learning spaces and its influence on social engagement?
- How do spatial qualities promote or hinder social interactions within these spaces?

***Space Syntax Methodology***

Space Syntax was utilized to analyze spatial configurations and their impact on social engagement. This method examines movement patterns and accessibility within environments, offering insights into the spatial relationships that shape social interactions (Hillier & Shinichi, 2005). Specifically, the study employed: 1) Convex Map and Bubble Diagram Analysis as visual tools to represent the spatial configuration of the environment and its connectivity; and 2) Axial Line and Visibility Analysis that represent the longest sightlines, highlighting movement paths and visual accessibility, critical for social interaction (Alnusairat et al., 2021; Campbell et al., 2022; Hipp et al., 2016; Lyu et al., 2023; Negm et al., 2020; Yunitsyna et al., 2024).

These spatial parameters were analyzed using DepthmapX software. The study analyzed the following Space Syntax parameters like integration, depth, choice, connectivity, and control. These parameters were crucial in identifying how spatial qualities influence social engagement, with a focus on visibility and axial line. The analysis measured axial integration and connectivity to identify areas with the highest potential for


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interaction, using color coding to visually represent the strength of connections (from red = strong to blue = weak).

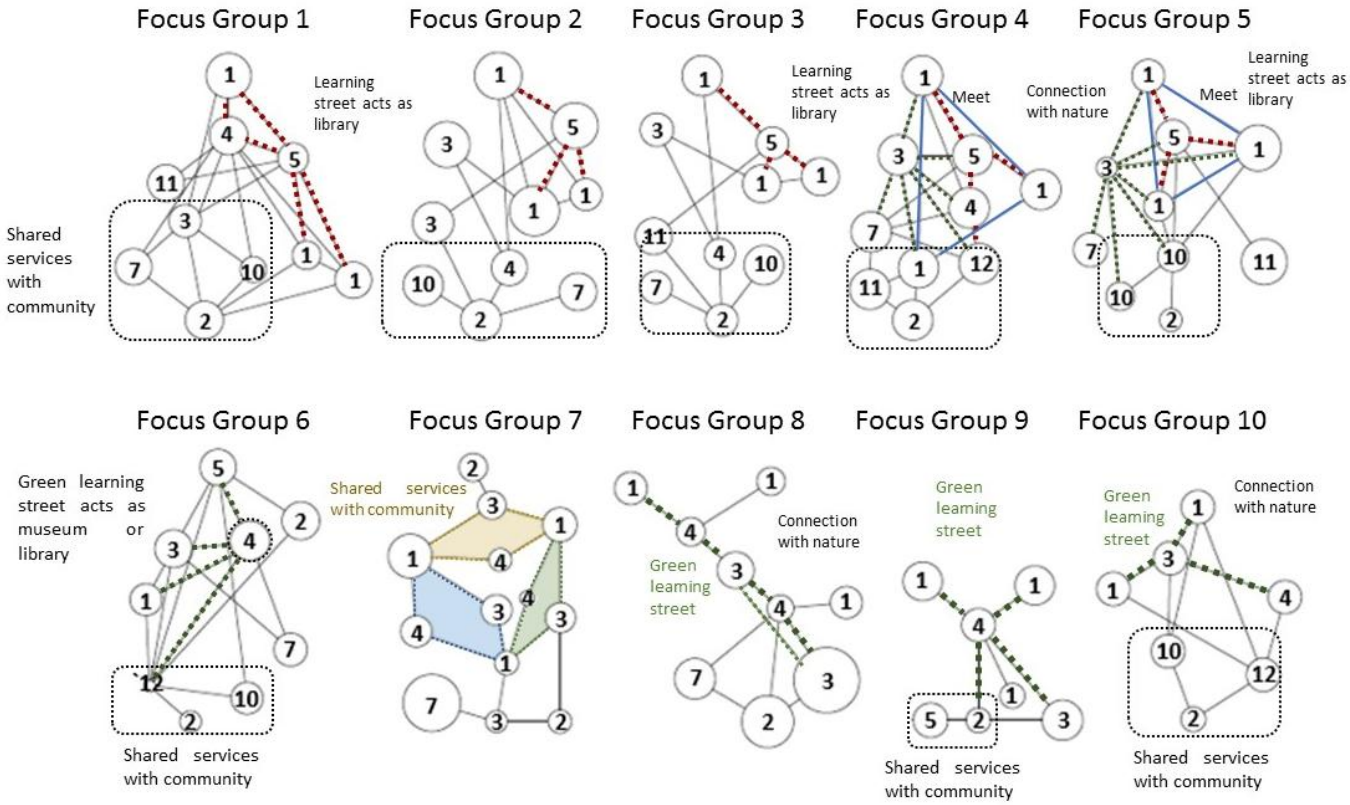


Figure 2 Bubble diagrams

***Data Analysis***

The qualitative data from group discussions were analyzed by Atlas-ti using a structured coding approach, which consisted of open, axial, and selective coding stages. The analysis began with open coding, where the data was examined in detail to identify key themes and patterns related to spatial qualities and social engagement. This process involved reviewing transcripts, field notes, and participant sketches. Through open coding, significant events, activities, and interactions were highlighted, particularly those related to spatial relationships and their effects on social behavior. Axial coding was followed, organizing similar codes into broader categories by linking open codes based on shared properties. This step allowed for a more refined structure of themes, focusing on important spatial features like visibility, connectivity, and integration. In the final stage, selective coding was employed to consolidate these categories into themes that directly addressed the research questions, providing a clearer understanding of how spatial design affects social dynamics.

While the study's findings are grounded in the context of the case study, they offer valuable insights into the broader relationship between spatial design and social engagement in educational settings. The iterative process of coding and validation ensured that the emerging themes accurately reflected both the participant perspectives and spatial dynamics within the school environment. However, the context-specific nature of this research means the generalizability of the findings may be limited.

Table 2 Open codes, axial codes, and emerging themes

| Emerging theme | Axial codes | Open codes |
|---|---|---|
| Spatial Diversity for Social Engagement | Spatial types; Spatial scale | The variety of spatial configurations and scales; Personal spaces and communal spaces; Large spaces and small spaces |
| Impact of Physical Environment | Dynamic and static spaces; Nature integration; Functionality; Flexibility; Shape and structure; Visibility; Connectivity | Adaptability; Continual reconfiguration; Adaptable environments; The ability of spaces to evolve and change based on needs; Evolving needs; Accommodating different activities; Multi-purpose rooms; Flexibility; Flexible place; Flexible use; Adapted various purposes; Varied spatial configurations |
| Adaptability in Design | Flexibility; Space evolution; Varied spatial configurations | Adaptability; Continual reconfiguration; Adaptable environments; The ability of spaces to evolve and change based on needs; Evolving needs; Accommodating different activities; Multi-purpose rooms; Flexibility; Flexible place; Flexible use; Adapted various purposes; Varied spatial configurations |
| Community Integration and | Social connectivity; Community | Connectivity; Social bond; A sense of belonging; Student |


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| | | |
|---|---|---|
| Multifunctional Spaces | integration; Versatility; Safety, security, and control | engagement; Interaction among students; Community engagement; Social connection; Multi-functional use; Community engagement; Community Integration; Inviting the wider community; Shared services with society; Multipurpose spaces shared with the community; Welcoming and safe atmosphere; External environments; Multifunctional Spaces; Bridges between education and society; Safety and security; Control; External connections |
| Transparency and Collaboration | Movement; Knowledge flow; Collaboration; Social integration; Transparency; Openness; Social zones | Movement; Knowledge flow; The flow of movement between floors and across a floor; Fluidity; Layouts that encourage exploration and interaction; Interaction; Communication; Collaboration; Group work; Social zones; Socialization; Group interaction; Social interaction |
| Balancing Openness with Focus | Openness; Flexibility; Focus; Individual work; Spatial integration; Depth; Sense of community; Communication | Choice; Connectivity; Spaces designed for focus and individual work; Open-plan spaces; Depth; Integrated space; Spatial integration; Individual levels, group levels, and organization levels; Openness; The sense of freedom; Individual focus; Communication and Concentration; Visibility; Transparency; A sense of community; Interconnected spaces. |

## Results and Discussion

The recurring themes related to spatial qualities and social engagement are used here to categorize the findings.

***Spatial Diversity for Social Engagement***

Diverse spatial configurations play a crucial role in promoting collaboration by offering individual and communal spaces for students to engage in various activities. These spaces, such as larger areas like libraries or museums, encourage group interactions, while smaller, individual spaces support concentration. The convex map analysis and visibility, as shown in Figure 3, highlight the most integrated areas, such as the yard and learning street, which are essential for encouraging social interaction (also see Chart 1). As the sixth group noted:

> Spaces should be the same in size but different in functions and with a common space with specific functions, improving the ability to meet the needs for socialization. It means we can expand and shrink spaces to suit our changing needs from individual tasks to collective engagements.

Research supports the connection between learning spaces and social engagement, with studies demonstrating that flexible, open environments promote collaborative and individual learning. Sasson et al. (2022) found that such spaces encourage cooperation, while Imms and Byers (2017) observed that flexible classrooms improve student engagement. Other researchers, including Horne-Martin (2002) and Kariippanon et al. (2019), emphasized the link between space design and teaching methods, with adaptable environments fostering exploration and collaboration. As Oblinger (2006) stated the design of a learning space directly influences pedagogical practices, further highlighting the importance of space in shaping student engagement.

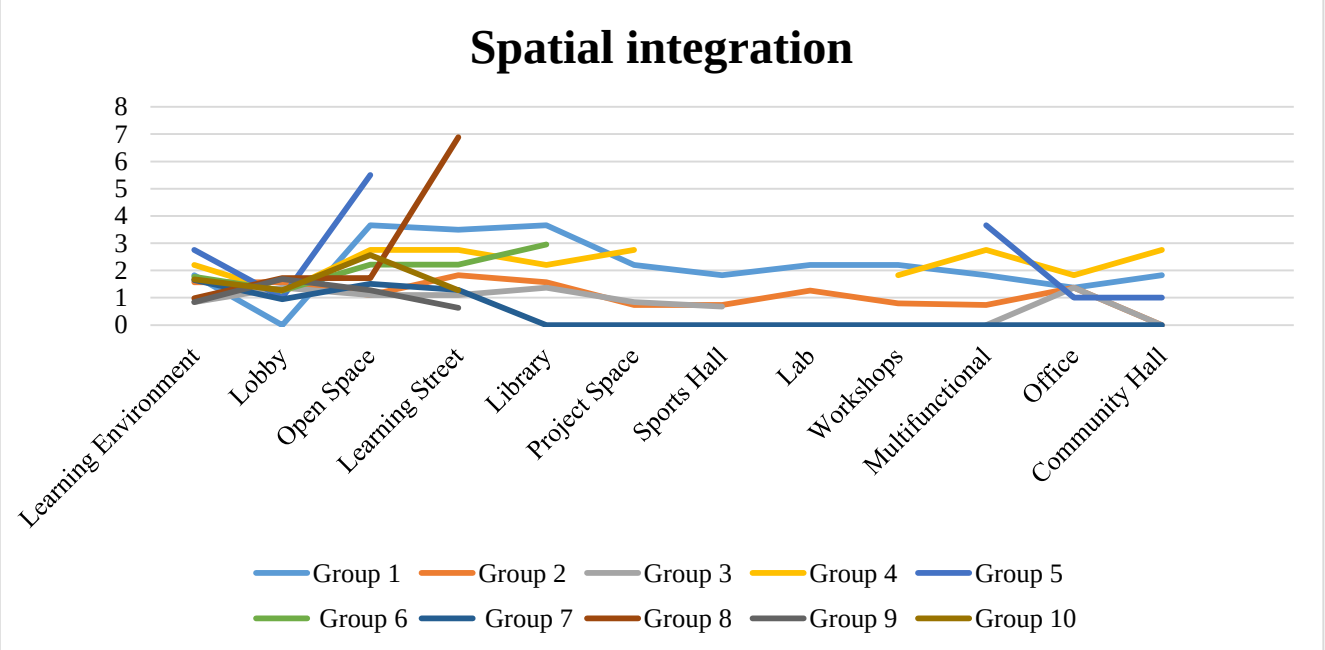


Chart 1 Spatial integration


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***Impact of Physical Environment***

The spatial qualities, such as size, the height of the ceiling, voids, openings, open spaces, and alignment with nature, play a significant role in student engagement. These elements foster a sense of freedom, while smaller spaces offer concentration (Figure 3). For example, multi-story learning environments improve social connections. They are more encouraging to foster communication if they are connected to nature. The ninth group stated:

> Large spaces and high ceilings stimulate creativity, while small spaces may hinder concentration. Thus, we need both small spaces and common spaces to concentrate and communicate.

Similarly, according to the sixth group,

> Spatial diversity encourages creativity and communication. A high ceiling gives freedom and peace to one's mind. Learning environments should be aligned with nature to encourage movement and communication.

Previous studies highlight the benefits of small class sizes, which allow for personalized interactions and more engaging educational experiences. Students in smaller classes are more accountable and likely to seek help when needed (Rusticus et al., 2023; Sadera et al., 2009). El-Darwish (2022) and Yaseen and Mustafa (2023) found that students value spaces with seating and shade to enhance social interactions. Using Space Syntax, it is recommended to create a pedestrian spine connecting social spaces while avoiding vehicle routes. Erkan (2018) demonstrated that ceiling height in transition spaces influences wayfinding.

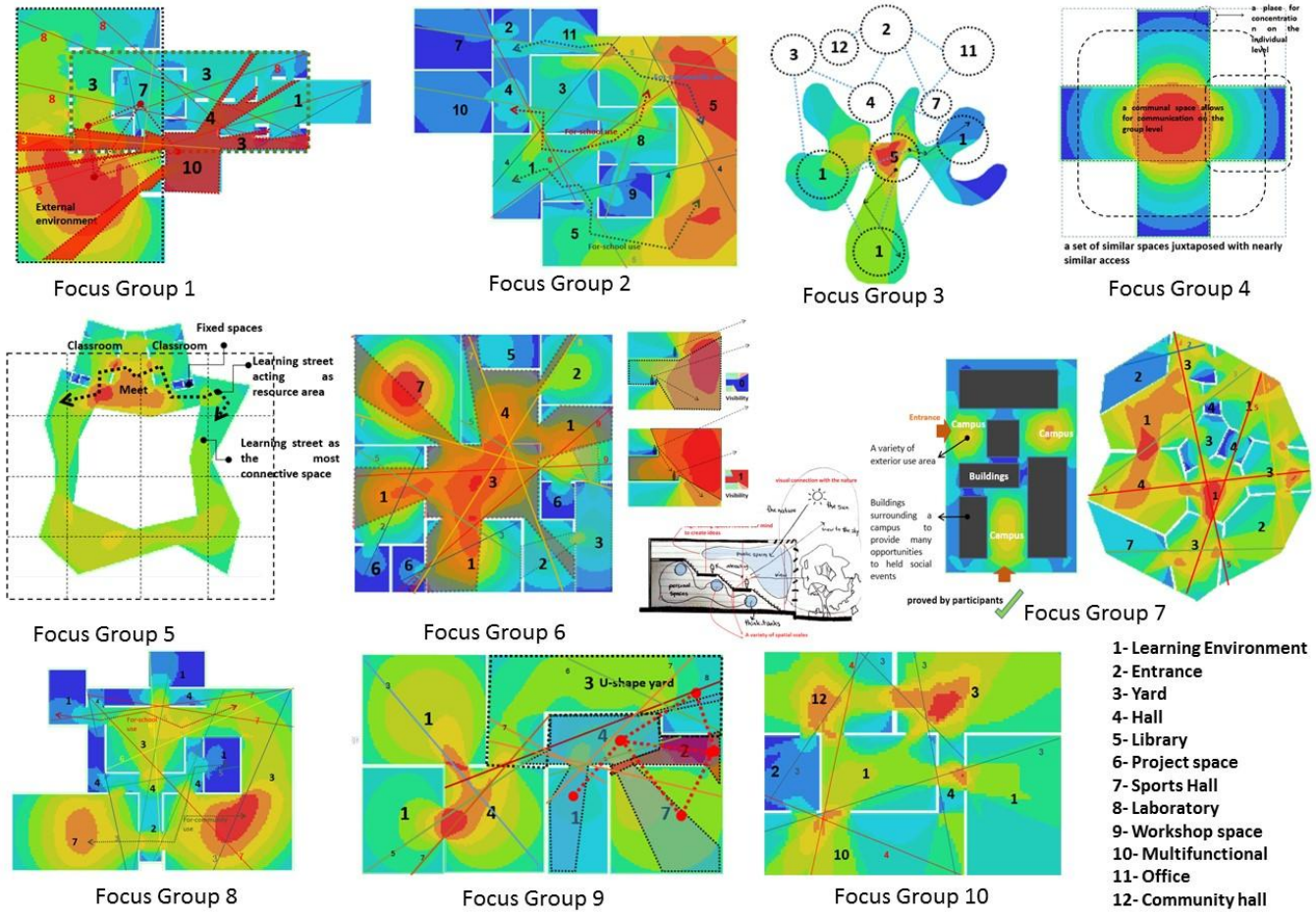


Figure 3 Sketches of participants and spatial analysis

***Adaptability in Design***

Adaptability is a crucial factor in the design of learning spaces. While open-plan spaces offer flexibility, participants emphasized that adaptable designs allow for continual reconfiguration of spaces as per evolving needs. This adaptability supports varied teaching methods and ensures that learning environments remain relevant. In addition to adaptability, participants stated that spaces with visible distances of 2, 10, and 40m allow for distinct functions at individual levels, group levels, and organization levels, respectively (Figure 3). As the first group noted, "Each space should create many interesting spaces outside and inside, offering students opportunities to explore a variety of choices."

While changing pedagogical practices is important, it alone is insufficient for achieving meaningful pedagogical transformation. As Woolner et al. (2018) argued, space changes should be part of a broader integrated approach that includes pedagogical, cultural, and organizational elements. This underscores the need for continued professional development. As Duthilleul (2018) observed, an open-space classroom does not inherently lead to improved learning outcomes; instead, its effectiveness depends on how it aligns with educational philosophy. Canter and Donald (1987) further highlighted that the physical layout alone is not sufficient; it must be complemented by the teacher's ability to adapt to the learning environment and decide when different teaching strategies are necessary (Imms & Byers, 2017; Imms, 2016; Morris et al., 2024).


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***Community Integration and Multifunctional Spaces***

According to Figures 2 and 3, schools can play a central role in bridging the gap between education and the community. Multifunctional spaces within schools are seen as vital for fostering stronger connections between students, parents, and the broader community. As the first group mentioned, "Some spaces should act as strong bridges between education and society. Designing spaces that serve multiple purposes can promote a variety of interactions with the external environment." However, there is a challenge in encouraging active social interactions, as both students and faculty desire more community engagement but are hesitant to make the effort (Rusticus et al., 2023).

In community schools, managers play a crucial role in shaping institutional identity and securing resources. However, challenges such as unclear roles and inconsistent support from local leadership often hinder their ability to effectively connect resources to the community school strategy (Hine et al., 2024). A supportive, welcoming school environment fosters a strong sense of community and student well-being. Designing an affirming school culture underscores the importance of physical space, student support, and inclusive policies in enhancing school connectedness and success (Fifolt et al., 2024). Community schools should prioritize creating environments that promote engagement, address diverse needs, and connect with the broader community.

***Transparency and Collaboration***

Open-plan and transparent spaces are fundamental for fostering collaboration (Figure 3). Chart 2 compares spatial connectivity, showing that areas like the yard and learning street are the most connected, suggesting they should serve as the most interactive zones.
El Samaty et al. (2023) concluded that glazing barriers enhance the visual performance of transition spaces by improving visual accessibility and supporting functional use, particularly in interactive areas, which suggested that glazing partially improves visual performance but requires further research for a more accurate assessment. Visibility analysis revealed that glazing has a significant impact on functional and visual performance, especially in terms of visual connectivity.

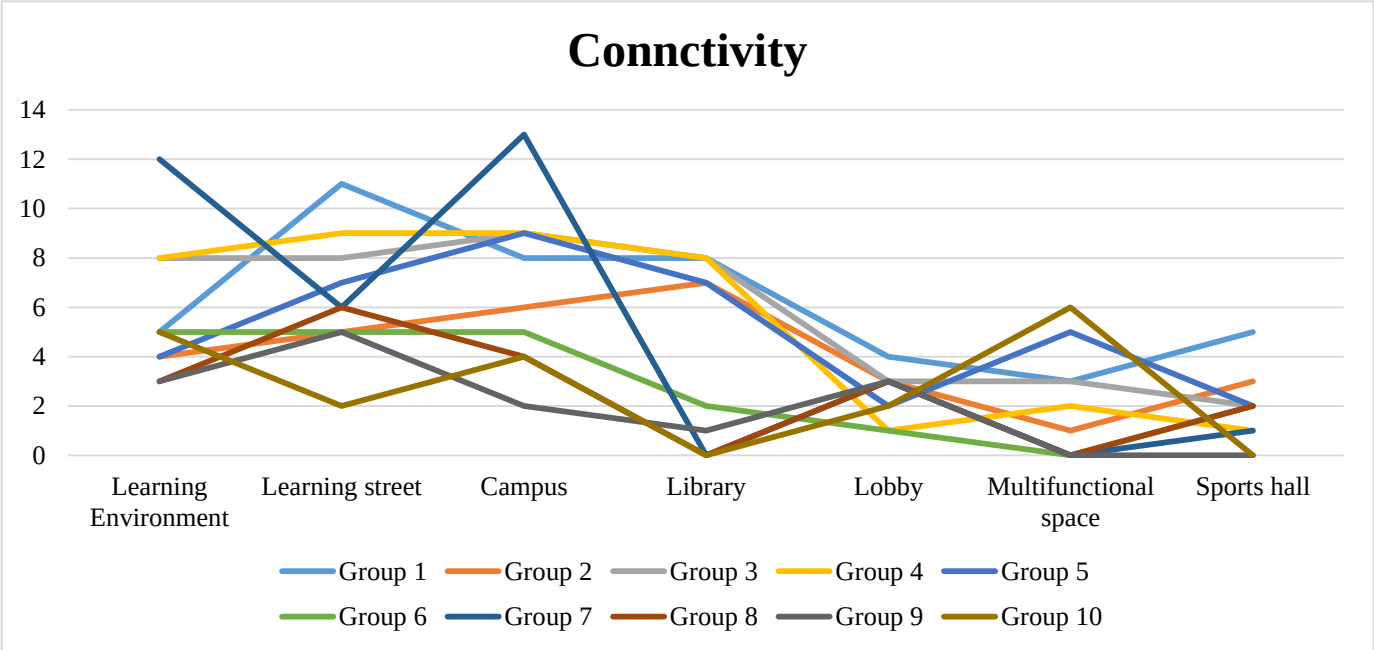


Chart 2 Spatial connectivity

***Balancing Openness with Focus***

While open-plan spaces encourage interaction, areas for privacy and focus are also crucial. The second and eighth groups designed U-shaped spaces, like a library and yard, surrounding the school to balance social interaction and concentration. These spaces were intended to serve both school and community needs. However, research by Safizadeh (2024) indicates that U-shaped and L-shaped plans tend to have the least efficient circulation, which could impede smooth movement within the space. Despite this, U-shaped designs still offer distinct learning opportunities by organizing areas that can be used independently for focused study or group collaboration. In addition to the shape, the sixth group also introduced stairs to improve spatial flow while maintaining areas for personal focus (Figure 3).

Chart 3 reveals that Groups 3, 7, and 8 preferred environments with greater spatial depth, such as the learning street or yard, which they found more conducive to concentration. These spaces, connected to nature, offered privacy and quiet. In contrast, other groups did not show a significant preference for spatial depth. Figure 2 highlights that the learning street and yard were chosen for their tranquility and outdoor connection, promoting focus.

However, poor acoustics in open spaces can disrupt communication, and a lack of private spaces may hinder confidential interactions. Balancing open areas for collaboration with quiet spaces for focused work is key. According to Chart 4 and Figure 3, the learning street, connected to nature and the learning environment, emerged as the most attractive space, though Groups 3 and 6 also favored the library, with no significant difference between the two.


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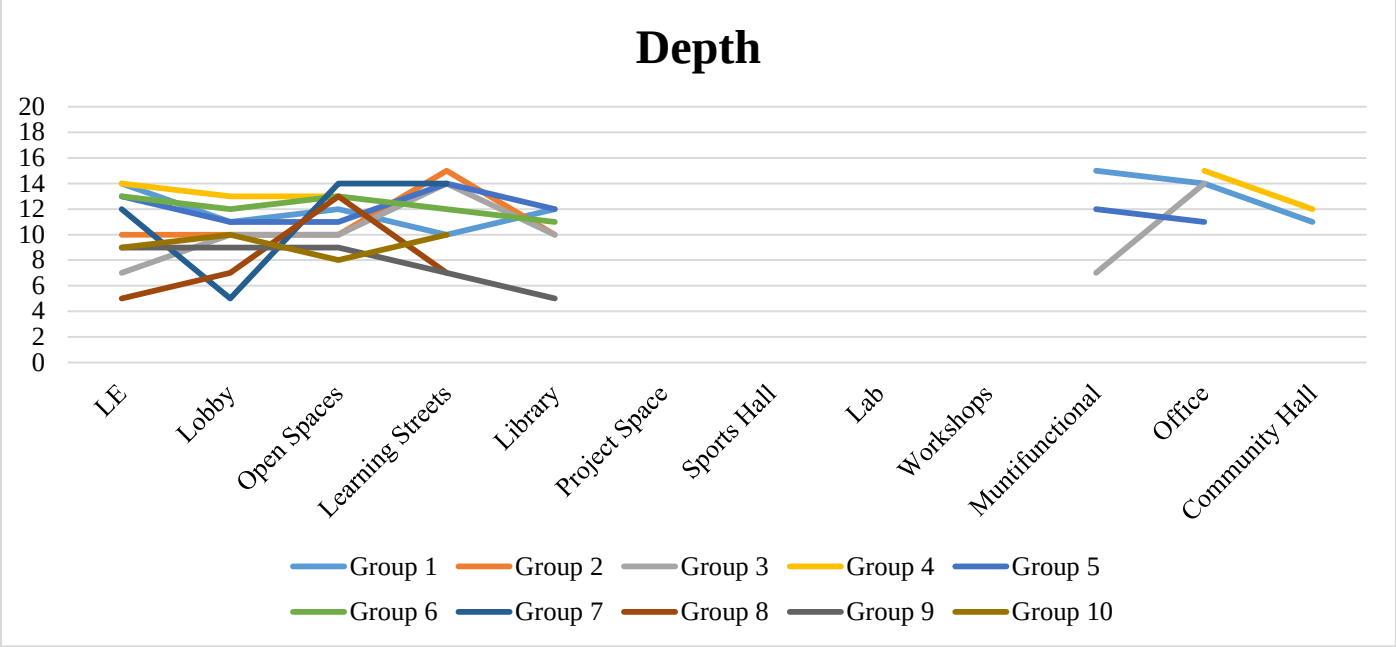


Chart 3 Spatial depth

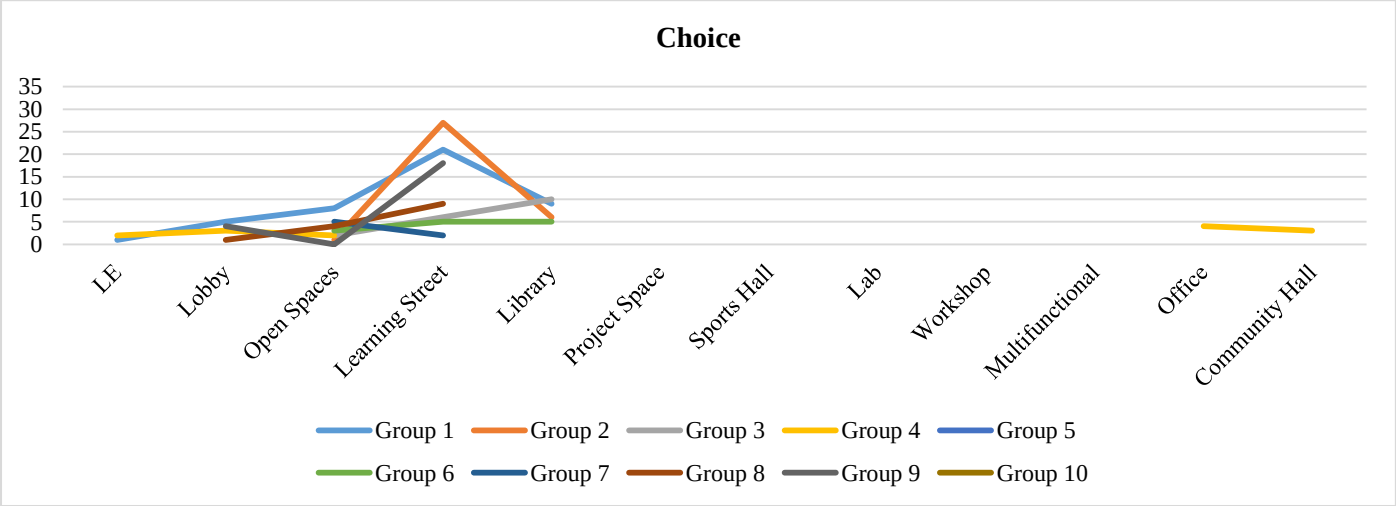


Chart 4 Spatial choice

## Conclusion

This study emphasizes the importance of spatial diversity in fostering social engagement and collaboration in school environments. Previous research, such as that by Sasson et al. (2022) and Imms and Byers (2017), has consistently shown that flexible, open learning spaces enhance student engagement and social interaction. The study's findings highlight the role of spaces like yards and learning streets in promoting social interaction while smaller, focused areas cater to individual tasks. These results align with the idea that a balance between open, collaborative spaces and private, concentrated zones is essential for effective learning.

Spatial qualities such as ceiling height, natural elements, and spatial depth were found to significantly influence student engagement in this study, further confirming findings by El-Darwish (2022) and Yaseen & Mustafa (2023). These studies also noted that features like natural light and varied spatial scales enhance both concentration and socialization. This research extends previous work by exploring how spatial diversity bridges the gap between education and community. It emphasizes the potential of multifunctional spaces to strengthen connections among students, teachers, and the wider community, contributing to a more holistic learning environment.

While these findings provide valuable insights, there are areas for further exploration. Future research should include longitudinal studies to assess the long-term impact of spatial design on student outcomes and school culture. Additionally, including diverse student populations could offer a deeper understanding of how spatial configurations affect various groups. Collaborative efforts between architects, educators, and students in the design process could yield valuable insights into creating spaces that meet the needs of diverse learners.

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